LAND SUBSIDENCE AND EARTH-FISSURE HAZARDS NEAR LUKE AIR FORCE BASE, ARIZONA

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Land subsidence and earth-fissure hazards near Luke Air Force Base are being investigated by the U.S. Geological Survey in cooperation with the U.S. Air Force. The main objectives of the investigation include the evaluation of land subsidence and earth-fissure hazards and the characterization of the surface- and subsurface-hydrogeologic conditions that may control the movement of contaminants toward and through the alluvial-aquifer system on and near the base. (See Ward and others, and Blodgett abstracts, for similar studies at Edwards Air Force Base). Differential land subsidence and resultant earth fissures have damaged buildings, roads, railroads, water wells, irrigation canals, and flood-control structures on or near the base, which is about 20 mi west of Phoenix, Arizona (fig. 1).

Large-scale pumping of ground water, mainly to irrigate crops in the surrounding area, has caused aquifer hydraulic heads measured in wells to decline more than 300 ft throughout much of the area. Ground-water depletion has caused the aquifer materials to compact and by 1991 had resulted in as much as 18 ft of land subsidence (fig 2). In August 1992, a Global Positioning System (GPS) satellite survey measured more than 17 ft of land subsidence northwest of the base (fig. 3). (See Ikehara #1, #2, and Pool #2 abstracts for GPS applications in land-subsidence investigations). Areas of maximum land subsidence correspond to areas of maximum hydraulic-head decline within the alluvial-aquifer system.

Large tensional breaks in the alluvial sediments, locally known as earth cracks or earth fissures, are caused by differential land subsidence. (See Haneberg and Helm abstracts for other possible mechanisms of earth-fissure formation). Earth-fissure zones as much as 2 mi long occur on the periphery of the areas of maximum land subsidence on three sides of the base (fig. 2). The earth fissures act as drains and are capable of capturing large volumes of surface runoff. When the fissures capture surface flows, the fissures enlarge by rapid erosion of the sides, by slumping, and by piping along the trend of the fissures. Such erosion can produce open fissure gullies as much as 15 ft deep and 30 to 40 ft wide in local areas. However, the fissures extend to depths far below the bottom of the fissure gullies and thus can provide vertical conduits for rapid downward movement of contaminants toward the water table. Part of the surface drainage from the south side of the base is captured by existing earth fissures.

The flood hazard on the base has been adversely affected by land subsidence. The gradient, or slope, of the Dysart Drain, which is a major flood-control channel along the north side of the base, has been reversed by differential land subsidence, and the carrying capacity of the drain and other flood-control structures has been greatly reduced (fig. 2). On September 20, 1992, a high-intensity storm produced about 4 in. of rain immediately north of the base and resulted in extensive flooding on the base. Floodwater overtopped the Dysart Drain and spilled onto the runways, into the aircraft parking areas, and into the base-housing area. The flooding closed the base for 3 days, inundated more than 100 homes, and generally disrupted base operations. Preliminary estimates of flood damage exceed $3 million.

Urbanization, together with commercial and industrial development, has occurred near the base in recent years. Any leakage of contaminants from the base into the nearby river channels or into the underlying body of ground water could affect the water resources of the area.

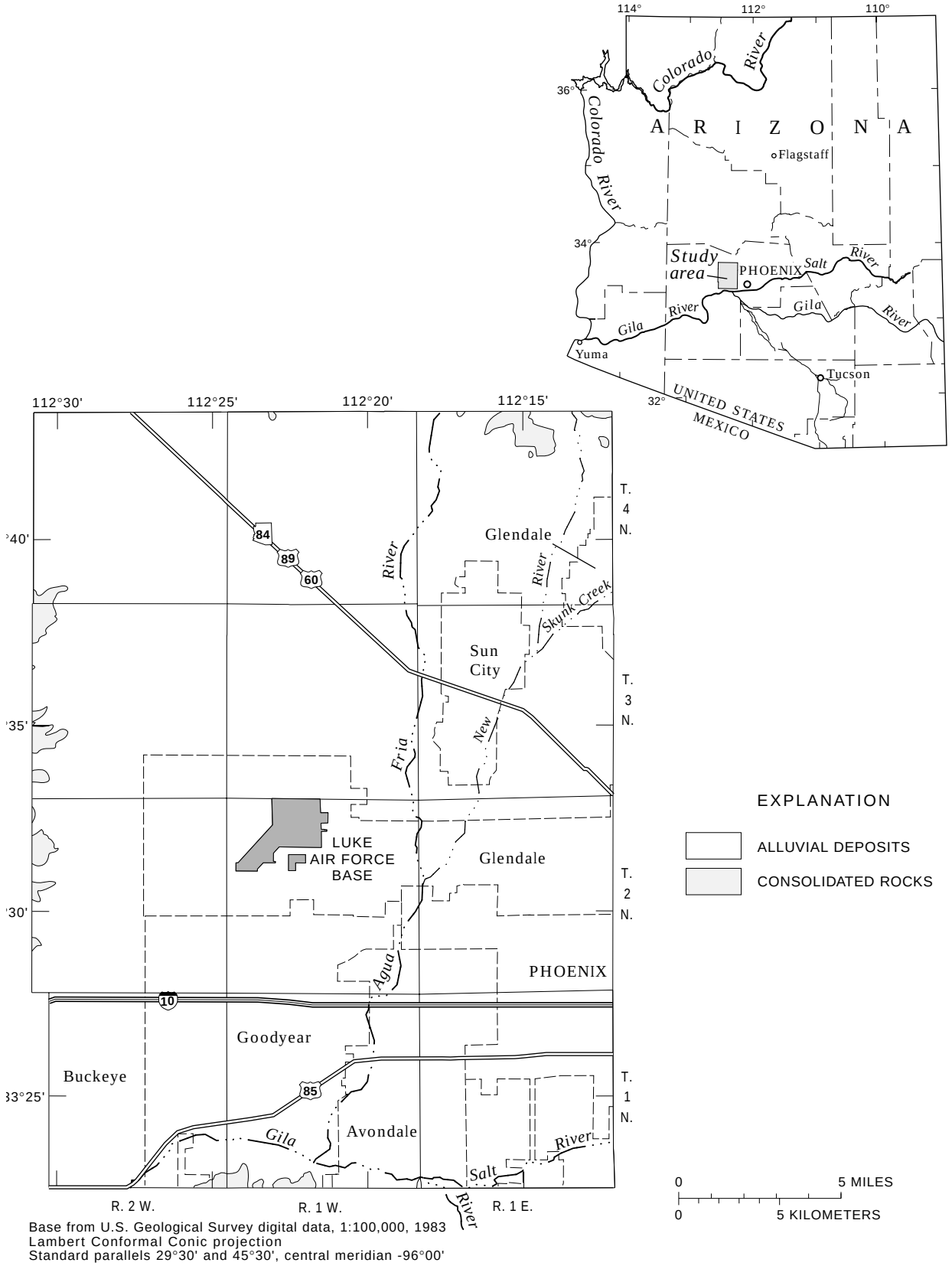

Figure 1. Location of Luke Air Force Base.

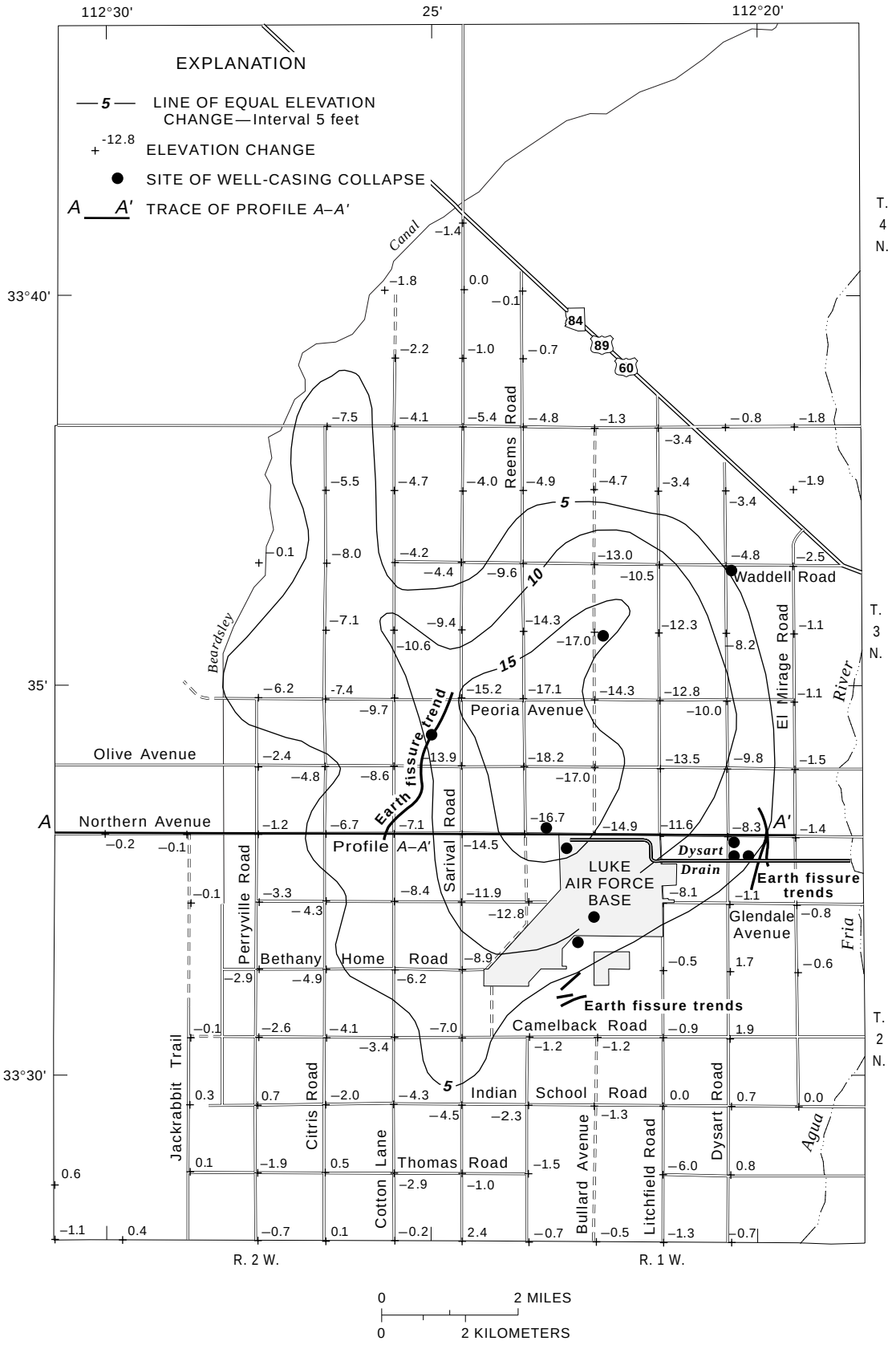

Figure 2. Land subsidence in part of the western Salt River Valley, 1957–1991.

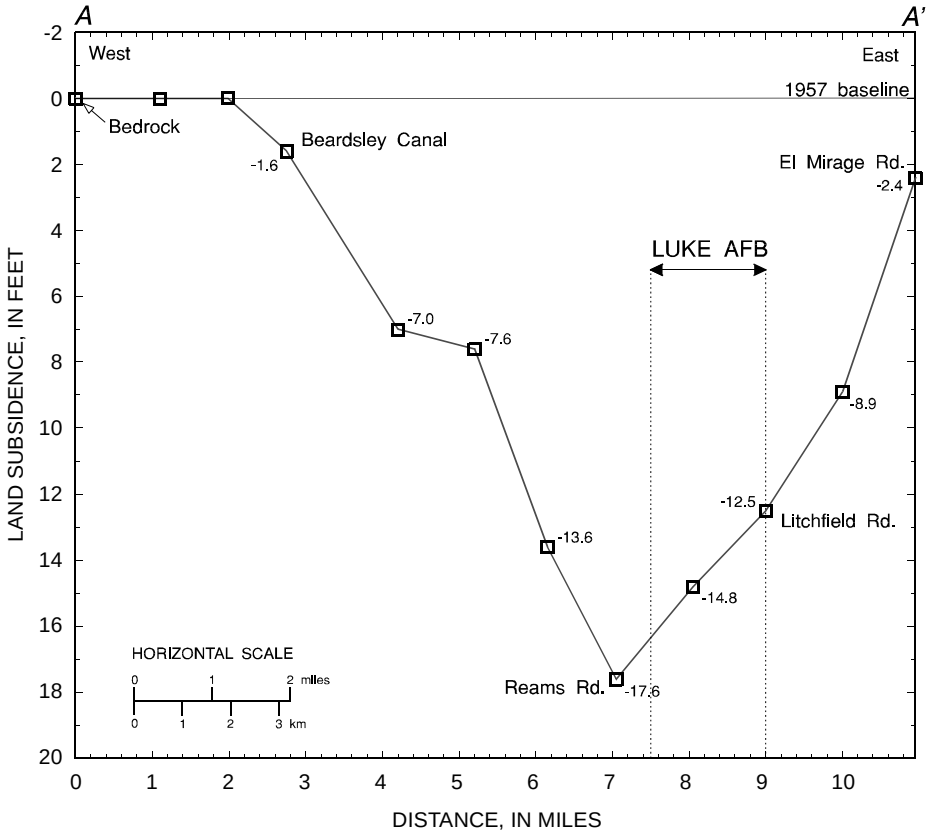

Figure 3. Profile of land subsidence, 1992, along Northern Avenue in the western Salt River Valley, Arizona.